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(54) [Title of Invention]
FLUORESCENCE OBSERVATION APPARATUS

(57) [Abstract]
 [Purpose]
 To provide a small fluorescence observation apparatus at low cost.

[Constitution]
 The wavelength of a laser beam emitted from a laser diode 21 can be set variably by temperature control via electronic cooling and heating means and fluorescence light having different wavelength can be excited as well as the fluorescence emitted from the tissue to be observed is introduced to a fluorescence imaging system in a TV (video) camera 3 via an image guide 32 of an endoscope 2, and a filter to be arranged on an optical path is selected by a filter switching means 9. Therefore, the fluorescence image with a different wavelength can be observed.

[Claims]

[Claim 1]

A fluorescence observation apparatus, which uses a semiconductor laser for a light source for excitation for fluorescence observation, which is characterized by:

a wavelength control means which changes the wavelength of a laser light emitted from said semiconductor laser by controlling the temperature of the semiconductor laser;
 a filter means which selectively changes the wavelength band entered to a fluorescence detecting apparatus for detecting fluorescence in accordance with the change of wavelength by the aforesaid wavelength control means.

[Detailed Description of the Invention]

[0001]

[Field of the Invention]

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This invention relates to a fluorescence observation apparatus which capable of changing the wavelength of a light for excitation by controlling the temperature of a laser diode.

[0002]

[Prior Art]

In recent years, there are techniques such as auto-fluorescence generated from living tissue and drug-induced fluorescence generated by injecting a fluorescent drug into the organism beforehand and produce two-dimensional images which are used to diagnose the degeneration of tissues of the organism or a state of the disease (for example, the type of the disease or the extent of infiltration), such as cancer.

[0003]

If light is irradiated to living tissue, the fluorescence of a wavelength longer than that of the excitation light will be emitted.

Fluorescence substances in the organism are, for example, collagen, NADH (nicotinamide adenine dinucleotide), FMN (flavin mononucleotide), pyridine nucleotide, etc. Recently, the interrelation between these substances in the organism emitting fluorescence light and diseases is becoming clear, and the diagnosis of cancer, etc. is possible from this fluorescence.

Alternatively, a fluorescence substance such as HpD (hematoporphyrin), Photofrin, ALA(δ -amino levulinic acid), etc., may be injected into an organism. These substances have a tendency to accumulate in cancerous tissue, and a diseased area can be diagnosed by observing the fluorescence after injecting any of these substances into an organism.

[0004]

By the way, when the above-mentioned fluorescence observation is performed, generally a laser light for excitation is irradiated to an area to be diagnosed. In this case, the laser light requires to have a suitable wavelength for excitation depending on the area to be diagnosed.

[0005]

[Problem to be Solved by this Invention]

As the result, several lasers, a dye laser which can generate several wavelengths or an alexandrite laser, etc. are required for a laser apparatus for excitation. Therefore, there are problems with the apparatus being large size or expensive.

[0006]

This invention is formed in consideration of the above-mentioned matters and aimed to provide a

fluorescence observation apparatus which can be miniaturized and inexpensive.

[0007]

[Means to Solve Problems and Effect]

The fluorescence observation apparatus of this invention, which uses a semiconductor laser as an excitation light source, controls the temperature of the semiconductor laser and provided with: a wavelength control means which changes the wavelength of a laser light emitted from the semiconductor laser; and a filter means which selectively changes the wavelength range which entered to a fluorescence light detecting apparatus depending on the change of the wavelength made by the aforesaid wavelength control means. Thus, by this invention, a wavelength region used by one semiconductor laser can be broaden and the apparatus can be miniaturized more than the one with other laser generator and it is possible to implement the apparatus at low price.

[0008]

[Embodiment]

Hereafter, embodiments of this invention will be explained referring to the drawings. Fig. 1 is a fluorescence observation apparatus of a first embodiment of this invention. Fig 1 is a diagram showing the structure of the fluorescence observation endoscope of a first embodiment of this invention. The fluorescence observation endoscope 1 of the first embodiment shown in Fig. 1 comprises: an endoscope 2; a TV (video) camera 3 which is detachably mounted to the endoscope 2 and equipped with an imaging means for normal observation and fluorescence observation; a light source device 4 for the endoscope which supplies illumination light to the endoscope 2 for normal observation; a light source device 5 for excitation light which generates excitation light for fluorescence observation; a CCU 6 which is connected to the TV (video) camera 3 and process a normal video image; an endoscope monitor 7 which displays an endoscope image by a output signal of this CCU 6; a fluorescence diagnosing apparatus 8 which is connected to the TV (video) camera 3 and processes the signal for generating a fluorescence image and displays the fluorescence image; a filter switching control means 9 which is connected to the light source 5 for excitation light and switches a filter used in a fluorescence imaging system inside the TV (video) camera 3 depending on the excitation light; and

an observation switching means 10 which indicates switching between a normal observation and a fluorescence observation.

[0009]

The aforesaid endoscope 2 consists of an elongated insertion part 11, an operating part 12 provided at the rear end of the insertion part 11, an eyepiece 13 provided at the rear end of the operating part 12 and a light guide cable 14 extended from the operation part 12, and a light guide 15 for transmitting the illumination light and the excitation light is inserted through the insertion part 11 and the light guide cable 14.

[0010]

This light guide 15 branches into two parts in the light guide cable 14 and one terminal of the light guide cable 14a is connected to the light source device 4. The white light of the lamp 17 which is emitted by the power from the power supply circuit 16 within the light source device 4 is supplied to the end face of the light guide 15 via a condenser lens 18. In addition, for a normal observation, a light-shielding plate 19 is kept at the condition of being retracted (from the optical path) as shown in Fig. 1.

[0011]

The other part of the light guide cable 15 is turned into a laser guide cable 14b and that terminal is connected to the excitation light source device 5. Then, the laser light from the laser diode 21 within the excitation light source device 5 is irradiated after gathered by a condenser lens 22. This laser diode 21 is activated by the power supply from a laser diode power supply circuit 23.

[0012]

Moreover, this laser diode 21 is attached to an electronic cooling and heating means 24 which is operated by the power supply from the power supply circuit for the electronic cooling and heating means 25. The laser diode power supply circuit 23 and the power supply circuit for the electronic cooling and heating means 25 are connected to a control means 26 so as to be controlled.

[0013]

This control means 26 is connected to a wavelength selection indicating means which is not illustrated. When the selection of the excitation wavelength is indicated by operating this wavelength selection indicating means, the control means 26 controls the temperature of the laser diode 21 via the electronic cooling and heating means 24 so as to emit light at the selected wavelength.

[0014]

The control means 26 reads a target temperature corresponding to the wavelength information based on the information of relationship between the light-emission wavelength and the temperature of the laser diode 21 recorded by ROM, etc. (not illustrated), as an address signal.

On the other hand, when a target temperature is set based on the output from a temperature sensor (not illustrated) which detects the actual temperature of the laser diode 21, the control means 26 first decides whether the laser diode should be heated or cooled in order to set to the target temperature. Then, it controls the electronic cooling and heating means 24 to perform cooling or heating operation based on the judgement and controls the laser diode 21 to be set and maintained at the target temperature by a feed back control loop.

[0015]

The control means 26 is also connected to a filter switching control means 9.

According to the selection of the wavelength of the excitation light by the wavelength selection indicating means, as well as the selection of the wavelength of the fluorescence light in case where the wavelength of the fluorescence light emitted by the excitation light having this wavelength changes, a filter that selectively transmits said fluorescence wavelength is set on the optical path of the fluorescence imaging system via the filter switching control means 9. (By rotating a filter turret 38 by a motor 42 which will be described later, the filter that selectively transmits the above fluorescence wavelength is set on the optical path.)

[0016]

In addition, a means to select or indicate the type of a fluorescence observation can be employed instead of the wavelength selection indicating means. By selecting a fluorescer with this means, the control means 26 reads out the wavelength of the laser light from ROM, etc. based on the wavelength of the excitation light which effectively excites this fluorescer and which is commonly used this type of a fluorescence observation, and it also calculates the target temperature corresponding to the wavelength (from ROM, etc.) and controls the temperature of the laser diode 21 to be set to that temperature. It may also be structured that the control means 26 controls the filter switching means 9 to arrange a filter which selectively transmits the wavelength of fluorescence observation on the optical path of the fluorescence imaging system.

[0017]

Thus, the apparatus according to the first embodiment is characterized by the fact that the wavelength of laser light, serving as excitation light, emitted from the laser diode can be changed by providing a wavelength control mechanism that controls the temperature of the laser diode and a filter means for observing fluorescence in the imaging means can be selectively set depending on the selected wavelength of the excitation light.

[0018]

The illumination light or the excitation light transmitted by the light guide 15 in the light guide cable 14 and the insertion part 11 is emitted from the end surface of the distal part of the insertion part 11 so as to irradiate an area to be diagnosed. The reflected light or the excitation light from the area is formed into an image on the distal surface of an image guide 32, arranged on the focus surface of an objective lens 31, by the objective lens 31 attached to the observation window of the distal part of the insertion part.

[0019]

Then, the image is transmitted to the end surface of the eyepiece 13 by the image guide 32. In the case of white illumination light, it can be viewed with naked eyes via the ocular lens 33. When the TV (video) camera 13 is mounted on this eyepiece 13, the image transmitted by the image guide 32 is projected on an imaging element such as a CCD 36 via an image forming lens 34 and a mirror 35 on the optical path.

[0020]

In addition, the imaging element is not limited to a CCD and a SIT (static induction transistor), a CMD (Charge Modulation Device), and a MOS type imaging element may be used.

[0021]

When the above-mentioned mirror 35 is retracted from the optical path, shown as the dotted line, by a device like a plunger 37, an image is formed on a CCD 41 via the image forming lens 34, a filter of the filter turret 38 arranged on the optical path of the image forming lens 34, and an image intensifier 39 for amplifying weak light. The optical path shown by the dotted line in Fig. 1 is the optical path for the fluorescence imaging system. Meanwhile, the optical path shown by the solid line is the path for the normal imaging system which consists of the image formation lens 34, the mirror 35 and the CCD 36 arranged on the optical path.

[0022]

Several filters whose transmission range respectively differs are attached in the direction of a disc circumference of the filter turret 38 so that the filter to be arranged on the optical path can be selectively set by a motor 42 that is a means to drive the filter turret.

[0023]

The mirror 35 in the TV camera 3 and the light-shielding plate 19 in the light source apparatus for endoscope 4 are driven in association with the operation of the observation switching means 10. In other words, when a normal observation switch in the observation switching means 10 is operated, the mirror 35 and the light-shielding plate 19 are set to the condition designated by the solid line in Fig. 1. The image of the area being illuminated with the white illumination light is formed on the CCD 36 by which it is photoelectrically converted to a normal endoscope image. Then the image is processed by the CCU 6 so that it is converted into a video signal by which a monitor can display the image, thus, the image is displayed on an endoscope image monitor 7. That is, a normal endoscope image can be observed by the endoscope image monitor 7.

[0024]

On the other hand, when a fluorescence observation switch in the observation switching means 10 is operated, the mirror 35 and the light shielding plate 19 are set in the condition shown as a dotted line in Fig. 1. The fluorescence image irradiated by the excitation light is formed on the CCD 41 via the filter of the filter turret 38 and the image intensifier 39. Then the fluorescence image which is photoelectrically converted by this CCD 41 is signal-processed by the signal processing circuit in the fluorescence diagnosing apparatus 8 so as to be displayed on the monitor in the fluorescence diagnosing apparatus 8.

[0025]

According to this first embodiment, the wavelength of laser light emitted from the laser diode 21 is variably set by controlling the temperature of the laser diode 21. Thus, a wide wavelength range can be covered by one laser diode 21.

[0026]

In this case, the laser diode 21 can be built very small and the electronic cooling and heating means 24 can also be built small. In addition, since the heat capacity of the laser diode 21 can be made small, an arbitrary temperature can be set in a very broad range by the small electronic cooling and heating means 24.

This means that the emitted wavelengths can also be varied in a broad range. Therefore, a large side laser apparatus such as a dye laser is not needed and a small laser apparatus for generating excitation light which can be applied widely can be realized.

[0027]

Furthermore, the filter turret 38 which plural filters are attached is provided in the TV (video) camera 3 with a function of fluorescence imaging system so that a filter to be arranged in an optical path can be selectively set via a filter switching indication means 9. Thus, a fluorescence observation can be performed by setting the filter which selectively transmits the wavelength of fluorescence being emitted. Also by this embodiment, a normal and a fluorescence observation can be performed by a simple switching operation.

[0028]

In Fig. 1, the laser guide cable 14b which transmits laser light is merged with the light guide cable 14a on the way. However, the guide cable which transmits laser light may be set apart from the light guide 15 which transmits illumination light. It may be structured to insert the laser guide in the channel of the endoscope.

[0029]

Fig. 2 illustrates a fluorescence observation apparatus 51 of a second embodiment of this invention. In the second embodiment, a second harmonic generator device (abbreviated to a SHG hereon) 52 is arranged in front of a laser diode 21' in an excitation light source 5' so that the laser light of the laser diode 21' outputs a second harmonic wave which is a half wavelength of the laser light. This laser diode 21' is to emit a laser light in long wavelengths such as infrared-ray region and the half wavelength of the laser light becomes the wavelength for excitation light.

[0030]

The aforesaid laser diode 21' emits flickering light by pulse (a pulse cycle P is 1/several 100 seconds for example) from a laser diode drive circuit 54 which outputs a pulse driving current based on the control pulse by a timing controller 53.

[0031]

Moreover, a fluorescence image is formed on a CCD 41 without passing through the image intensifier 39 in the TV (video) camera 3 of the first embodiment. The CCDs 36 and 41 in the TV (video) camera 3 are operated by drivers 55 and 56 respectively. In this case, the readout cycle of one frame of the CCD 36 is

operated by 1/30 second. On the other hand, the readout cycle of the CCD 41 is operated by the double (speed) of pulse cycle P so that imaging signal of the CCD 41 is output when the excitation-light pulse is output and when it is not output.

Furthermore, the fluorescence diagnosing apparatus 57 in this embodiment consists of a two-dimensional lock-in amplifier 58 and a CCU 59 and a monitor 60.

[0032]

The two-dimensional lock-in amplifier 57 comprises: an A/D converter 61 for converting the image signal into digital data; a multiplexor 63 for distributing image data to a first frame memory 62a and a second frame memory 62b for each frame to correspond to turning on and off of excitation light that passes through the laser diode 52 in synchronization with the timing controller 53; a differential circuit 64 for difference-calculating the first frame memory 62a and the second frame memory 62b so as to cancel noise components; and an integration circuit 65 that integrates (in such a manner that the same image portions are respectively accumulated) images from which noise components have been cancelled so as to improve the S/N ratio and amplify the image.

[0033]

In this two-dimensional lock-in amplifier 57, the image data respectively detected by the blinking (turning on and off) of light of the laser diode 52 is processed by the differential circuit 64. Thus, the influence of noise that is not related to turning on and off and that of 1/f noise which becomes critical by low frequency waves can significantly be eliminated. Therefore, weak image signals of a fluorescence image can be formed into fluorescence image signals exhibiting excellent S/N ratio.

[0034]

Moreover, after the image data is converted to the image data of 1/30 seconds by the integration process by this integration circuit 6 and converted into an analog image signal by D/A converter not illustrated, it is entered to a CCU 59 so as to be converted into a standard video signal and than a fluorescence image is displayed on a monitor 60.

[0035]

The other components, such as a component for controlling the temperature of the laser diode 21' to produce a double wavelength of the wavelength actually required for the excitation light and a component for setting a filter of the imaging system selectively depending on the wavelength of the

fluorescence to be observed, are the same as that of the first embodiment.

[0036]

According to the second embodiment, since an inexpensive laser diode 21' which produces laser light in a long wavelength which is a double wavelength of the excitation light can be used instead of the laser diode 21 which emits the wavelength of the excitation light directly, an apparatus can be realized by a further cost reduction.

By using the two-dimensional lock-in amplifier 57, a fluorescence image with an excellent S/N ratio can be obtained.

Fig. 3 illustrates an endoscope apparatus 71 of a third embodiment of this invention. In the second embodiment, the laser diode 21' was provided in the excitation light source 5 that was located outside of the endoscope 2. However, in this embodiment, a laser diode 21', etc. are provided inside the endoscope 72 and the necessary power to the power supply circuit 73 is supplied by a laser diode power supply circuit 73 located outside (of the endoscope).

[0037]

As shown in Fig. 4, the insertion part 74 of the endoscope 72, the light guide 15 and the image guide 32 are inserted like the first embodiment and an illumination lens 75 and an objective lens 31 are respectively arranged on the distal portion. In the endoscope 72, a laser diode 21' which is attached to the electronic cooling and heating means 24 and a SHG 52 and an illumination lens 76 are arranged on the distal portion of the insertion part 74.

[0038]

The laser diode 21' and the cooling and heating means 24 are connected to a signal line 77. This signal line 77 are inserted to a signal cable 78, which is branched off from the light guide cable 14, and respectively connected to a laser diode drive circuit 54 and the power supply circuit 25 for the electronic cooling and heating means in the laser diode power supply circuit 73. Other structures are similar to that of the second embodiment and operation and effects are almost the same as that of the second embodiment.

[0039]

In addition, an apparatus can be structured to simply irradiate the excitation light having the wavelength that is half of the wavelength of the laser diode 21' by providing a laser diode 21' and a SHG 52 in the endoscope 72 and by supplying a drive signal from the outside laser diode 21' via signal line. In this case, there are following advantages.

[0040]

If the 442nm-excitation light is required, He-Cd laser is usually used; however, it is large and expensive. Thus, if this excitation light is required, because it is inexpensive to buy the laser diode that emits a 882nm-laser light, the same function can be obtained at low cost by using a laser diode instead of a He-Cd laser. In addition, a laser diode can be provided in the distal portion of the endoscope since it can be made very small.

[0041]

Fig. 5 illustrates an endoscope apparatus 81 of a fourth embodiment of this invention.

This apparatus comprises:

a rigid endoscope 82;
a light source device for endoscope 4 to supply illumination light for normal observation to the light guide of the rigid endoscope 82;
an excitation light source device 5' to supply laser light for excitation;
a scope holder 84 which is connected to the eyepiece 83 of the rigid endoscope 82;
a TV (video) camera 85 provided at the proximal end of the scope holder 84; and
a display unit 86 for displaying endoscope images and fluorescence images.

[0042]

The light guide cable 14 is connected to the mouth piece of the light guide of the holding part 90 formed on the rear end of the insertion part 89 of the rigid endoscope 82. The light guide cable 14a which is branched off from the light guide cable 14 is connected to the light source 4 from which white illumination light is supplied.

[0043]

The laser guide cable 14a which is branched off from the laser guide cable 14 is connected to the excitation light source 5' from which excitation laser light is supplied.

The white illumination light and the excitation laser light are transmitted by the light guide in the rigid endoscope 82 and then irradiated from the end face of the distal portion.

[0044]

The reflected light from the illuminated area to be diagnosed or fluorescence emitted by excitation light is formed an image via the objective lens on the distal part and transmitted to the rear image guide such as relay optical system. The image transmitted can be observed by the eyepiece 83 if it is a visible image.

[0045]

The scope holder 84 which is connected to the eyepiece 83 has an arm part 84a which contains a rod lens and a rotatable joint part 84b for example, and it transmits the image transmitted to the eyepiece 83 to the TV (video) camera 85 that is connected to the proximal part of the scope holder 84.

[0046]

The mirror 35 retractable from an optical path by a plunger 37 is arranged on the incident optical path of this TV (video) camera 85. The light reflected by the mirror 35 is reflected by a second mirror 92 and a third mirror 93, and then projected to a CCD 96 via the fourth mirror 95 retractable by a plunger 94 from the optical path.

[0047]

In addition, when the above-mentioned mirrors 35 and 95 are in the position of being retracted from the optical path, an image is formed on a CCD 96 via a filter of the filter turret 98 rotated by a motor 97 and an image intensifier 39.

[0048]

In addition, it can be structured to arrange a filter of the filter turret 98 in the optical path of a fluorescence imaging system via the motor 97 by operating a switch, etc. In this embodiment, a normal endoscope image and a fluorescence image can be obtained by a common CCD 96. Other structures have the similar effects as that of the first embodiment.

[0049]

It may also be structured to use plural laser diodes which have different emitting wavelengths to broaden the wavelength region of excitation light and to select the laser diode according to the wavelength actually required for the excitation light.

[0050]

In this case, a SHG may be used as required. In order to increase the output of light emission, it can use plural laser diodes, each of which emits light with one wavelength. Note that the foregoing embodiments may partially be combined with each other to constitute another embodiment.

[0051]

[Effect of the Invention]

According to this invention described above, the wavelength of light irradiated can be changed by controlling the temperature of the semiconductor laser to be used for excitation light and also a filter means which guides fluorescence light from the

tissue to be examined to a fluorescence imaging system is provided so that a small fluorescence observation apparatus can be realized at low cost.

[Brief Explanation of Drawings]

[Fig. 1]

a structural diagram of a fluorescence observation apparatus of a first embodiment of this invention.

[Fig. 2]

A structural diagram of a fluorescence observation apparatus of a second embodiment of this invention.

[Fig. 3]

a structural diagram of a fluorescence observation apparatus of a third embodiment of this invention.

[Fig. 4]

a diagram showing the structure of an optical system of the endoscope used in the example of the third embodiment.

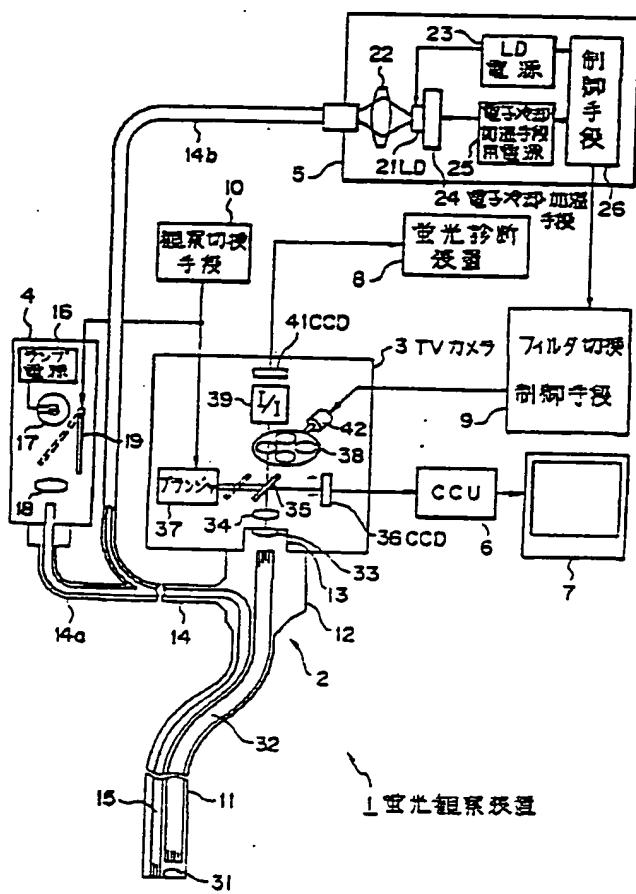
[Fig. 5]

a structural diagram of a fluorescence observation apparatus of a fourth embodiment of this invention.

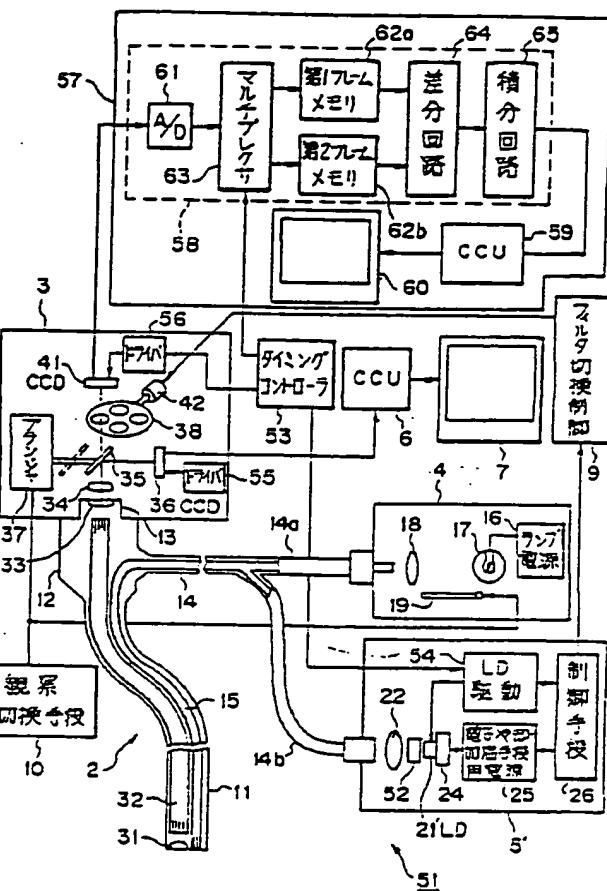
[Explanation of Symbols]

- 1...fluorescence observation apparatus
- 2...endoscope
- 3...TV (video) camera
- 4...light source for endoscope
- 5...excitation light source
- 6...CCU
- 7...a monitor for an endoscope image
- 8...fluorescence diagnostic apparatus
- 9...filter switching control means
- 10...observation switching means
- 11...insertion part
- 13...eyepiece
- 14...light guide cable
- 14b...laser guide cable
- 15...light guide
- 17...lamp
- 19...a light-shielding plate
- 21...laser diode
- 23...laser diode power source circuit
- 24...electronic cooling and heating means
- 25...power source circuit for electronic cooling and heating means
- 26...control means
- 35...mirror
- 36, 41...CCD
- 38...filter turret
- 39...image intensifier

[Fig. 1]



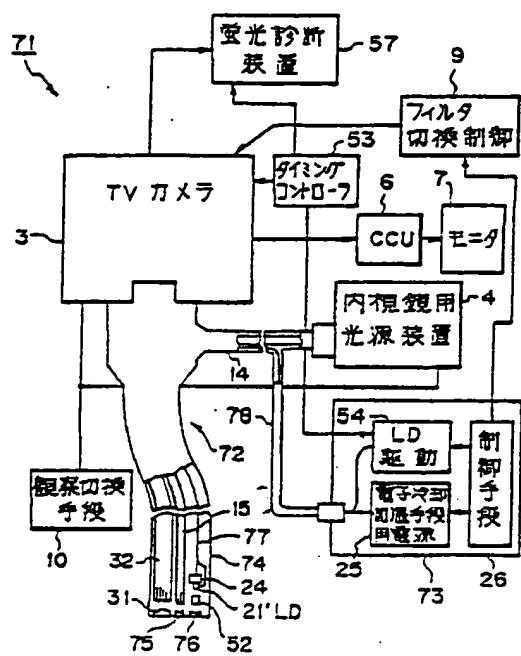
[Fig. 2]



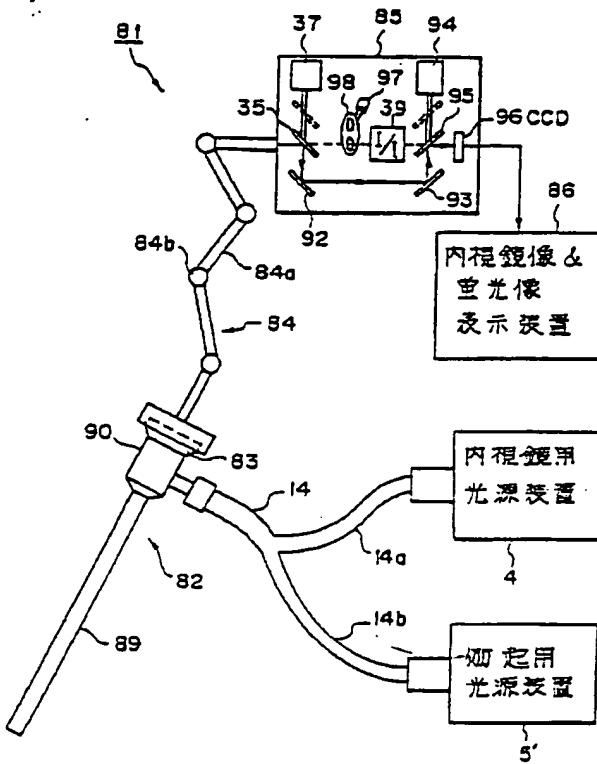
- 1. Fluorescence observation apparatus
- 3. TV camera
- 8. Fluorescence diagnostic apparatus
- 9. Filter switching control means
- 10. Observation switching means
- 16. Lamp light source
- 23. LD light source
- 24. Electronic cooling/heating means
- 25. Light source for electronic cooling/heating means
- 26. Control means
- 37. Plunger

- 53. Timing controller
- 54. LD drive
- 55. Driver
- 62a. First frame memory
- 62b. Second frame memory
- 63. Multiplexer
- 64. Differential circuit
- 65. Integration circuit

[Fig. 3]



[Fig. 5]



TV camera

4. Light source apparatus for endoscope

7. Monitor

9. Filter switching control means

10. Observation switching means

25. Light source for electronic cooling/heating means

27. Control means

53. Timing controller

54. LD drive

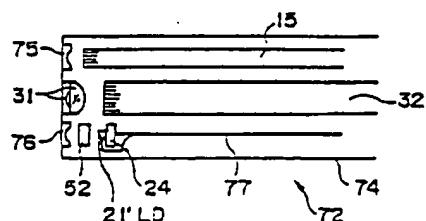
56. Fluorescence diagnostic apparatus

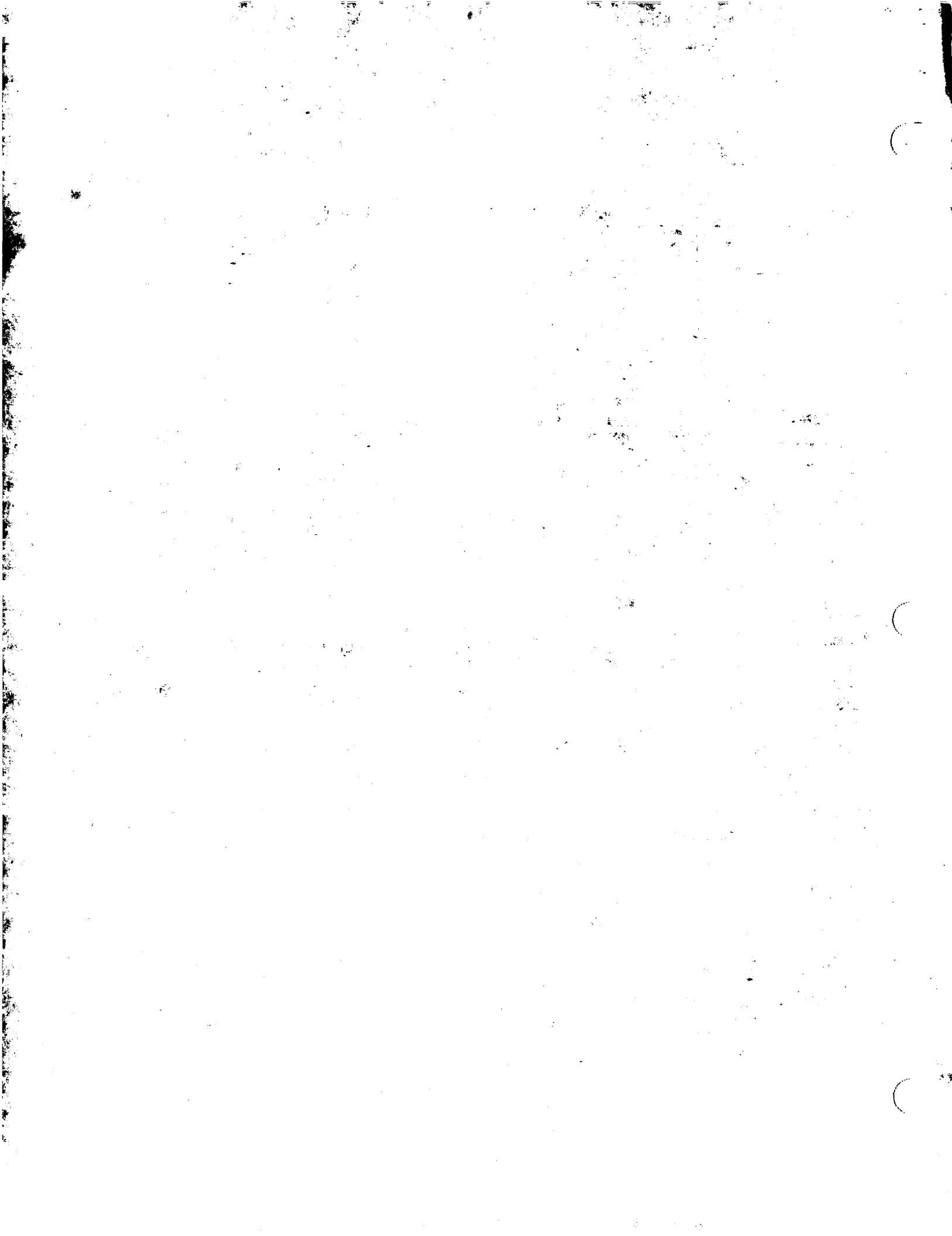
4. Light source apparatus for endoscope

5'. Excitation light source apparatus

86. Display unit for endoscope and fluorescence images

[Fig. 4]





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(57)【要約】

(57)[SUMMARY]

【目的】

小型化及び低価格化できる蛍光
観察装置を提供すること。

[OBJECT]

Provide the fluorescent observation apparatus
which can be done a size-reduction and a
lowering of cost.

【構成】

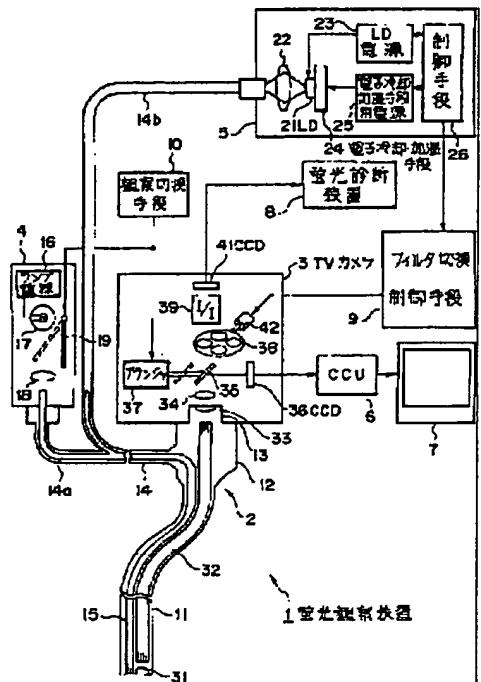
レーザダイオード21で発光さ
れるレーザ光の波長を電子冷
却・加温手段24を介して温度
制御を行うことにより可変設定
でき、波長が異なる蛍光を励起
できるようにすると共に、対象
組織側からの蛍光は内視鏡2の
イメージガイド32を介してTV
カメラ3内の蛍光撮像系に導
かれ、光路上に配置されるフィ
ルタをフィルタ切換手段9によ
り選択して、異なる波長の場
合の蛍光像を観察可能にしてい
る。

[SUMMARY OF THE INVENTION]

The variable setup of the wavelength of the
laser radiation which emits light by the laser
diode 21 can be carried out by controlling a
temperature through an electronic cooling and
heating means 24.

While enabling it to excite the fluorescence
from which a wavelength differs, the
fluorescence from an objective structure side is
guided to the fluorescent image-pick-up system
in the TV camera 3 through the image guide 32
of an endoscope 2.

The filter arranged on the optical path is
chosen by filter switching means 9, and the
fluorescent image in the case of a different
wavelength is carried out observably.



1 : Fluorescent observing apparatus, 3 : TV camera, 8 : Fluorescent-diagnosis apparatus, 9 : Filter switching control means, 10 : Observation switching means, 16 : Lamp Power supply, 23 : Laser-diode power supply circuit, 24 : Electronic cooling and heating means, 25 : Power supply circuit for Electronic cooling and heating means, 26 : Control means, 37 : Plunger

【特許請求の範囲】

[CLAIMS]

【請求項 1】

半導体レーザを蛍光観察のための励起用光源に用いる蛍光観察装置において、半導体レーザの温度を制御することにより、該半導体レーザから出射されるレーザ光の波長を

[CLAIM 1]

In the fluorescent observing apparatus which uses a semiconductor laser for the light source for excitation for a fluorescent observation, wavelength control means to change the wavelength of the laser radiation by which a radiation is carried out from this semiconductor

変える波長制御手段と、前記波長制御手段による波長変化に応じて蛍光を検出するための蛍光検出装置に入射される波長域を選択的に変えるフィルタ手段とを設けたことを特徴とする蛍光観察装置。

laser by controlling temperature of a semiconductor laser, filter means to change selectively the wavelength range by which incidence is carried out to the fluorescent detector for detecting a fluorescence depending on the wavelength variation by above-mentioned wavelength control means were provided.

The fluorescent observation apparatus characterized by the above-mentioned.

【発明の詳細な説明】

[DETAILED DESCRIPTION OF INVENTION]

【0001】

[0001]

【産業上の利用分野】

本発明はレーザダイオードの温度を制御して励起用光の波長を可変設定する蛍光観察装置に関する。

[INDUSTRIAL APPLICATION]

This invention relates to the fluorescent observing apparatus which controls temperature of a laser diode and carries out the variable setup of the wavelength of the light for excitation.

【0002】

[0002]

【従来の技術】

近年、生体からの自家蛍光や、生体へ薬物を注入し、その薬物の蛍光を2次元画像として検出し、その蛍光像から、生体組織の変性や癌等の疾患状態（例えば、疾患の種類や浸潤範囲）を診断する技術がある。

[PRIOR ART]

In recent years, a medicine is injected to the private fluorescence from the organism, and the organism, and it is detected, using the fluorescence of the medicine as a two-dimensional image.

From the fluorescent image, there is a technique that illness condition (for example, the kind and permeation range of the illness),

such as the denaturation of a living tissue and cancer, is diagnosed.

【0003】

生体組織に光を照射するとその励起光より長い波長の蛍光が発生する。生体における蛍光物質として、例えばNADH (ニコチンアミドアデニンヌクレオチド), FMN (フラビンモノヌクレオチド), ピリジンヌクレオチド等がある。最近では、このような、生体内因物質と、疾患との相互関係が明確になってきた。また、HpD (ヘマトポルフィリン), Photofrin, ALA (δ -aminolevulinic acid) は、癌への集積性があり、これを生体内に注入し、前記物質の蛍光を観察することで疾患部位を診断できる。

[0003]

If a light is irradiated to a living tissue, the fluorescence of a wavelength longer than the excitation light will carry out generation.

As the fluorescent material in the organism, for example, there are NADH (nicotinamide adenine nucleotide), FMN (flavine mononucleotide), pyridine nucleotide, etc.

Recently, such interactive relationship between endogenous substance in the living body and the illness becomes clear.

Moreover, HpD (hematoporphyrin), Photofrin, and ALA (δ -amino levulinic acid) have the integrated property to cancer.

The illness site can be diagnosed by injecting this to the living body and observing the fluorescence of an above-mentioned material.

【0004】

ところで、上記蛍光観察を行う場合、励起用レーザ光を対象となる診断部位に照射することが一般的に行われる。この場合、励起用レーザ光は診断部位に応じて、その励起に適した波長が必要になる。

[0004]

When performing an above fluorescence observation by the way, in general, irradiating the laser radiation for excitation to the diagnostic site which becomes objective is performed.

In this case, as for the laser radiation for excitation, the wavelength suitable for the excitation is needed depending on the diagnostic site.

【0005】

[0005]

【発明が解決しようとする課題】

このため、励起用レーザ装置としては複数のレーザ、又は複数の波長を発振できる色素レーザ、アレキサンドライトレーザ等が必要になり、装置が大型化したり、高価になってしまう欠点があった。

[PROBLEM ADDRESSED]

For this reason, as laser apparatus for excitation, some lasers or the dye laser which can oscillate some wavelengths, an alexandrite laser, etc. are needed.

There were faults that the apparatus enlarged or became expensive.

[0006]

本発明は上述した点にかんがみてなされたもので、小型化及び低価格化できる蛍光観察装置を提供することを目的とする。

[0006]

This invention was made in view of the above-mentioned point carried out, and aims at providing the fluorescent observing apparatus made a size-reduction and a lowering of cost.

[0007]

[0007]

【課題を解決するための手段および作用】

本発明では半導体レーザを蛍光観察のための励起用光源に用いる蛍光観察装置において、半導体レーザの温度を制御することにより、該半導体レーザから出射されるレーザ光の波長を変える波長制御手段と、前記波長制御手段による波長変化に応じて蛍光を検出するための蛍光検出装置に入射される波長域を選択的に変えるフィルタ手段とを設けることにより、1つの半導体レーザで使用できる波長領域を広げ、他のレーザ発生装置を用

[A SOLUTION OF THE INVENTION and an effect]

In the fluorescent observing apparatus which uses a semiconductor laser for the light source for excitation for a fluorescent observation in this invention, wavelength control means to change the wavelength of the laser radiation by which a radiation is carried out from this semiconductor laser by controlling temperature of a semiconductor laser, and filter means to change selectively the wavelength range by which incidence is carried out to the fluorescent detector for detecting a fluorescence depending on the wavelength variation by above-mentioned wavelength control means are provided. BY this, the wavelength area which

いる場合よりも小型化でき、しかも低価格で実現可能にしていく。

can be used by one semiconductor laser is extended, and it can reduce in size more than the case where the other laser generator is used.

And implementation is made possible at a low cost.

【0008】

[0008]

【実施例】

以下、図面を参照して本発明の実施例を説明する。図1は本発明の第1実施例の蛍光観察装置の構成を示す。図1に示す第1実施例の蛍光観察装置1は、内視鏡2と、この内視鏡2に着脱自在で装着され、通常観察及び蛍光観察の撮像手段を備えたTVカメラ3と、内視鏡2に通常の観察のための照明光を供給する内視鏡用光源装置4と、蛍光観察のための励起光を発生する励起用光源装置5と、TVカメラ3と接続され、通常の映像処理を行うCCU6と、このCCU6の出力信号により内視鏡像を表示する内視鏡像モニタ7と、TVカメラ3と接続され、蛍光像を生成する信号処理及び蛍光像を表示する蛍光診断装置8と、励起用光源装置5と接続され、励起光に応じてTVカメラ3内の蛍光撮像系で使用するフィルタを切換えるフィルタ切換え制御手段9と、通常観察及

[Example]

Hereafter, the Example of this invention is demonstrated with reference to a drawing.

Diagram 1 shows the constitution of the fluorescent observing apparatus of the 1st Example of this invention.

The fluorescent observing apparatus 1 of the 1st Example shown in Diagram 1, is composed of an endoscope 2, a TV camera 3 which is detachable to this endoscope 2, is installed, and was equipped with photographing means of a usual observation and a fluorescent observation, a light source device for endoscopes 4 which supplies the illumination light for a usual observation to an endoscope 2, a light source device for excitation 5 which carries out generation of the excitation light for a fluorescent observation, and CCU6 which is connected with the TV camera 3 and performs a usual video process, an endoscope image monitor 7 which displays an endoscope image by this output signal of CCU6, a fluorescent-diagnosis apparatus 8 which displays the signal processing which is connected with the TV camera 3 and forms a fluorescent image, and a fluorescent image, a filter change control

び蛍光観察とを切換える指示を行ふ観察切換手段10とから構成される。

means 9 which switches the filter which connects with the light source device for excitation 5, and is used by the fluorescent photographing system in the TV camera 3 depending on excitation light, and an observation switching means 10 to perform the indication which switches a usual observation and a usual fluorescent observation.

【0009】

上記内視鏡2は細長の挿入部11と、この挿入部11の後端に設けられた操作部12と、この操作部12の後端に設けられた接眼部13と、この操作部12から延出されたライトガイドケーブル14とからなり、挿入部11及びライトガイドケーブル14内には照明光及び励起光を伝送するライトガイド15が挿通されている。

[0009]

The above endoscope 2 consists of the long and slender insertion part 11, the operating part 12 provided to the rear end of this insertion part 11, the eye-piece part 13 provided to the rear end of this operating part 12, and the light-guide cable 14 extended from this operating part 12. The light guide 15 which transmits an illumination light and excitation light in the insertion part 11 and the light-guide cable 14 is passed through.

【0010】

このライトガイド15はライトガイドケーブル14部分で2本に分岐され、一方のライトガイドケーブル14aの端部は内視鏡用光源装置4と接続される。そして、内視鏡用光源装置4内のランプ電源回路16からの電源で発光するランプ17の白色光がコンデンサレンズ18を介してライトガイド15の端面に供給される。なお、通常観察の場合には遮光板19は図1のように退避した状態に保持され

[0010]

This light guide 15 is branched to two in light-guide cable 14 part.

The edge part of one light-guide cable 14a is connected with the light source device for endoscopes 4.

And, the white light of the lamp 17 which emits light with the power supply from the lamp power supply circuit 16 in the light source device for an endoscope 4 is supplied to the end face of a light guide 15 through a condenser lens 18.

In addition, in a usual observation, the shading board 19 is kept at the condition of

る。

having evacuated as shown in Diagram 1.

【0011】

ライトガイドケーブル14における分岐された他方はレーザガイドケーブル14bとなり、その端部は励起用光源装置5に接続される、そして、励起用光源装置5内のレーザダイオード21からのレーザ光がコンデンサレンズ22で集光されて照射される。このレーザダイオード21はレーザダイオード電源回路23からの電源で駆動される。

[0011]

The other branched side in the light-guide cable 14 serves as laser guide cable 14b. The edge part is connected to the light source device for excitation 5.

And, the laser radiation from the laser diode 21 in the light source device for excitation 5 is condensed and irradiated by the condenser lens 22.

The driving of this laser diode 21 is carried out with the power supply from the laser-diode power supply circuit 23.

【0012】

また、このレーザダイオード21には電子冷却・加温手段24が接合等して取り付けてあり、この電子冷却・加温手段24は電子冷却・加温手段用電源回路25からの電源で駆動される。レーザダイオード電源回路23と電子冷却・加温手段用電源回路25は制御手段26と接続され、この制御手段26によって制御される。

[0012]

Moreover, electronic cooling and heating means 24 makes the synizesis etc. to this laser diode 21, and it has attached to it.

The driving of this electronic cooling and heating means 24 is carried out with the power supply from the power supply circuit for electronic cooling and heating means 25. The laser-diode power supply circuit 23 and the power supply circuit for electronic cooling and heating means 25 are connected with control means 26.

It controls by this control means 26.

【0013】

この制御手段26は図示しない波長選択指示手段と接続され、この波長選択指示手段を操作して励起光の波長の選択指示を行うと、制御手段は選択指示された波長でレーザダイオード21

[0013]

This control means 26 is connected with wavelength-selection indication means not to illustrate. If this wavelength-selection indication means is operated and the choice indication of the wavelength of excitation light is performed, control means will control temperature of a

を発光させるように電子冷却・加温手段 24 を介してレーザダイオード 21 の温度を制御する。

laser diode 21 at the wavelength that it chose and indicated, through electronic cooling and heating means 24 so that a laser diode 21 may emits light.

[0014]

制御手段 26 は例えば図示しない ROM 等に記録されたレーザダイオード 21 の発光波長と温度との関係情報から波長情報をアドレス信号として対応する目標温度を読み出し、一方実際のレーザダイオード 21 の温度を検出する図示しない温度センサの出力を基準にして、目標温度に設定する場合に加熱すべきか冷却すべきかをまず判断し、その判断の後、電子冷却・加温手段 24 の冷却又は加温動作を行わせて目標温度と一致するようフィードバック制御ループでレーザダイオード 21 を目標温度に設定維持する制御を行う。

[0014]

Control means 26 reads the target temperature which corresponds wavelength information as an address signal for example, from information on relationship between the light-emission wavelength of the laser diode 21 and the temperature which were recorded by ROM which is not illustrated.

On the one hand, it is based on the output of the temperature sensor which is not illustrated but detects temperature of the actual laser diode 21.

First, it decides whether it should heat or cool when setting it as target temperature. The control which sets and keeps the laser diode 21 at target temperature by the feedback control loop so that cooling or heating operation of electronic cooling and heating means 24 may be performed and it may be in agreement with target temperature is performed after the judgment.

[0015]

また、制御手段 26 はフィルタ切換え制御手段 9 とも接続され、波長選択指示手段の励起光の波長選択指示と共に、その波長の励起光により発光する蛍光の波長が変化する場合には蛍光の波長の選択指示を行うと、このフィルタ切換え制御手段 9 を

[0015]

Moreover, as for control means 26, filter change control means 9 is connected. When the fluorescent wavelength which emits light by the excitation light of the wavelength with the wavelength-selection indication of the excitation light of wavelength-selection indication means varies, it is set as that which permeates the wavelength of an above fluorescence

介して蛍光撮像系の光路上には上記蛍光の波長を選択的に透過するものに設定されるようにしている（後述するモータ42によりフィルタターレット38を回転し、光路上に配置されるフィルタが上記蛍光の波長を選択的に透過するものに設定される）。

selectively on the optical path of a fluorescent photographing system, through this filter change control means 9, when the choice indication of a fluorescent wavelength is performed. (Rotating the filter turret 38 by the motor 42 mentioned later. The filter arranged on the optical path is set as that which permeates the wavelength of an above fluorescence selectively.)

【0016】

また、この波長選択指示手段の代わりに、蛍光観察の種類等を選択或は指示する手段を設け、この手段から蛍光剤の選択を行

うことにより、制御手段26はその蛍光剤で一般的に使用される蛍光観察の波長の励起光を効率的に励起させるレーザ光の波長をROM等から読み出し、かつその読み出した波長から（ROM等により）対応する目標温度も求め、その目標温度となるようにレーザダイオード21の

温度制御を行うと共に、蛍光観察の波長を選択的に透過するフィルタを蛍光撮像系の光路上に配置するようにフィルタ切換手段9を制御するようにしても良い。

[0016]

Moreover, means to choose or indicate the kind of fluorescent observation etc. is provided instead of this wavelength-selection indication means.

By choosing a fluorescence agent from this means, control means 26 reads out the wavelength of the laser radiation which excites efficiently the excitation light of the wavelength of the fluorescent observation used in general by the fluorescence agent from ROM etc. And it also obtains the target temperature which corresponds (by ROM etc.), from the wavelength of readout.

While performing the temperature control of a laser diode 21 so that it may become the target temperature, it may control filter switching means 9 so that the filter which permeates the wavelength of a fluorescent observation selectively, may be arranged on the optical path of a fluorescent photographing system.

【0017】

このように第1実施例では、レーザダイオード21から励起光として発光するレーザ光の波長

[0017]

In this way, in the 1st Example, by providing the wavelength control system which controls the wavelength of the laser radiation which

をその温度を制御する波長制御機構を設けることにより、励起光の波長を可変設定できるようになると共に、励起光として設定される波長に応じて撮像手段側での蛍光観察のためのフィルタ手段のフィルタを選択的に可変設定できるようにしていることが特徴となっている。

emits light as excitation light from a laser diode 21 the temperature, the variable setup of the filter of filter means for the fluorescent observation in the side of photographing means selectively depending on the wavelength set up as excitation light, while it makes the variable setup of the wavelength of excitation light possible. The above-mentioned has been the feature.

【0018】

上記ライトガイドケーブル 14 内及び挿入部 11 内のライトガイド 15 で伝送された照明光又は励起光は挿入部 11 の先端部側の端面から出射され、診断部位等を照明する。診断部位側からの反射光又は励起光は先端部の観察窓に取り付けられた対物レンズ 31 によってその焦点面に配置されたイメージガイド 32 の先端面に像を結ぶ。

[0018]

The radiation of the illumination light or the excitation light transmitted by the light guide 15 in the above light-guide cable 14 and the insertion part 11 is carried out from the end face by the side of the point of an insertion part 11.

The diagnostic site etc. is illuminated.

The reflected light or the excitation light from a diagnostic site side is an image the bind to the end surface of the image guide 32 arranged on the focal plane with the objective lens 31 attached to the observation port of a point.

【0019】

そして、イメージガイド 32 によって接眼部 13 側の端面に伝送され、白色照明光の場合には接眼レンズ 33 を介して肉眼で観察できる。この接眼部 13 に T V カメラ 3 が装着された場合には、結像レンズ 34、光路上のミラー 35 を介してイメージガイド 32 で伝送された像が撮像素子としての例えば C C D 36 に結像される。

[0019]

And, the image guide 32 transmits to the end face by the side of the eye-piece part 13, and, in the case of a white illumination light, it can observe through an eyepiece 33 with the naked eye.

When the TV camera 3 is installed in this eye-piece part 13, the image transmitted by the image guide 32 through the image-formation lens 34 and the mirror 35 on an optical path is formed on for example, CCD 36 as photographing element.

【0020】

なお、撮像素子としてはCCDに限定されるものでなく、SIT（静電誘導トランジスタ）、CMD（Charge Modulation Device）、MOSタイプの撮像素子等を用いてもよい。

[0020]

In addition, as an photographing element, it is not limited to CCD, but photographing elements such as SIT (static induction transistor), CMD (Charge Modulation Device), and MOS type etc. may be used.

【0021】

上記ミラー35が例えればプランジャ37で点線で示すように光路上から退避された場合には、結像レンズ34、この結像レンズ34の光路上に配置されたフィルターレット38のフィルタ、微弱光を增幅するイメージ・インテンシファイア39を介してCCD41に結像される。図1の点線で示す光路は蛍光撮像系の光路となり、一方、実線で示す光路上に配置された結像レンズ34、ミラー35、CCD36が通常観察の撮像系を形成する。

[0021]

When the above mirror 35 is evacuated, for example, from an optical path with a plunger 37 as shown by a dotted line, It image-forms on CCD41 through the image-formation lens 34, the filter of the filter turret 38 which is arranged on the optical path of this image-formation lens 34, and the image * intensifier 39 which amplifies a feeble light.

The optical path shown by the dotted line of a diagram 1 turns into the optical path of a fluorescent photographing system.

On the one hand, the image-formation lens 34 which is shown by a continuous line and which was arranged on the optical path, the mirror 35, and CCD36 usually form photographing system of the observation.

【0022】

上記フィルターレット38は、円板の周方向に、それぞれ透過域が異なる複数のフィルタが取り付けられており、フィルターレット駆動手段としてのモータ42により、光路上に配置される1つのフィルタを選択設定できる。

[0022]

As for the above filter turret 38, some filters whose permeation region respectively differs is attached in the circumferential direction of a disc.

By the motor 42 as filter turret driving means, the choice setup of the one filter arranged on the optical path can be carried out.

【0023】

TVカメラ3内のミラー35と内視鏡用光源装置4内の遮光板19は観察切換手段10の操作によって連動して駆動される。つまり、観察切換手段10における通常観察スイッチを操作すると、ミラー35と遮光板19は図1の実線で示す状態に設定され、白色照明光で照明された状態での被写体像がCCD36に結像され、このCCD36で光電変換された通常の内視鏡像がCCU6で信号処理されてモニタに表示可能な映像信号に変換され、内視鏡像モニタ7で表示される。つまり、通常の内視鏡像が内視鏡像モニタ7で観察できる。

[0023]

A mirror 35 in the TV camera 3 and a shading board 19 in the light source device for endoscopes 4 interlock by operation of observation switching means 10 and are driven. In other words, operation of the usual observation switch in observation switching means 10 sets a mirror 35 and the shading board 19 to the condition which shows as the continuous line of Diagram 1. The photographed-object image in the condition of having illuminated with the white illumination light is image-formed on CCD36. The signal processing of the usual endoscope image by which the photoelectric conversion was carried out on this CCD36 is carried out on CCU6. The conversion is carried out to a video signal displayable to a monitor.

It displays on the endoscope image monitor 7.

In other words, a usual endoscope image can observe with the endoscope image monitor 7.

【0024】

一方、観察切換手段10における蛍光観察スイッチを操作すると、ミラー35と遮光板19は図1の点線で示す状態に設定され、励起光で照明された状態での蛍光による像がフィルターレット38のフィルタ、イメージ・インテンシファイア39を介してCCD41に結像され、このCCD41で光電変換された蛍光像が蛍光診断装置8内の

[0024]

On the one hand, operation of the fluorescent observation switch in observation switching means 10 sets a mirror 35 and the shading board 19 into the condition which shows by the dotted line of Diagram 1. The image by the fluorescence in the condition of having illuminated by excitation light is formed on CCD41 through the filter of the filter turret 38, and the image * intensifier 39. The signal processing of the fluorescent image by which the photoelectric conversion was

信号処理回路で信号処理され、この蛍光診断装置8内のモニタに表示される。

carried out on this CCD41 is carried out in the signal-processing circuit in the fluorescent-diagnosis apparatus 8.

The monitor in this fluorescent-diagnosis apparatus 8 displays.

[0025]

この第1実施例によれば、レーザダイオード21の温度を制御して、その発光するレーザ光の波長を可変設定できるようにしているので、1つのレーザダイオード21により、広い波長範囲をカバーできる。

[0025]

According to this 1st Example, since temperature of a laser diode 21 is controlled and it can carry out the variable setup of the wavelength of the laser radiation which emits light, the large wavelength range can cover by the one laser diode 21.

[0026]

この場合、レーザダイオード21は非常に小型にできるし、電子冷却・加温手段24も小型にでき、しかもレーザダイオード21の熱容量は小さくできるので小型の電子冷却・加温手段24により非常に広い範囲で任意の温度に設定できることになり、発光する波長も広範囲に可変できることになる。従って、色素レーザ等の大型のレーザ装置を必要とすることなく、適用範囲の広い、かつ小型の励起光発生用レーザ装置を実現できる。

[0026]

In this case, a laser diode 21 is made very small.

And, electronic cooling and heating means 24 can also be made small.

And since the thermal capacity of a laser diode 21 is made small, it can set an arbitrary temperature in an extremely wide range, by a small-sized electronic cooling and heating means 24.

The wavelength which emits light can also be varied broadly.

Therefore, large-sized laser apparatuses, such as a dye laser, are not needed.

A widely applicable and small laser apparatus for excitation-light generation is realizable.

[0027]

さらに、蛍光撮像系の機能を備えたTVカメラ3には、複数のフィルタが取り付けられたフィ

[0027]

Furthermore, the filter turret 38 to which some filters were attached is provided for the TV camera 3 equipped with function of a

ルタターレット38が設けてあり、フィルタ切換選択手段9を介して光路上に配置されるフィルタを選択設定できるようにしてあるので、実際に発光する蛍光の波長を選択的に透過するフィルタを光路上に設定して蛍光観察を行うことができる。また、この実施例では通常観察と蛍光観察とを簡単な切換え操作で行うことができる。

fluorescent photographing system.

Since the choice setup of the filter arranged on the optical path through filter switching choice means 9 is carried out, the filter which permeates selectively the fluorescent wavelength at which light actually is emitted can be set up on the optical path, and a fluorescent observation can be performed.

Moreover, this Example can perform the usual observation and a fluorescent observation by simple change operation.

【0028】

なお、図1ではレーザ光を伝送するレーザガイドケーブル14bはライトガイドケーブル14aと途中で合流しているが、レーザ光を伝送するガイドケーブルを照明光を伝送するライトガイド15と分離して設けるようにしても良い。また、内視鏡のチャンネルを利用してそのチャンネル内にレーザガイドを挿通しても良い。

[0028]

In addition, laser guide cable 14b which transmits a laser radiation in Diagram 1 is converged in the middle of light-guide cable 14a.

However, the guide cable which transmits a laser radiation may be separated from the light guide 15 which transmits an illumination light, and may be provided.

Moreover, a laser guide may be passed through into the channel using the channel of an endoscope.

【0029】

図2は本発明の第2実施例の蛍光観察装置51を示す。この第2実施例では励起用光源装置5'内のレーザダイオード21'の前に2次高調波発生素子(セカンド・ハーモニック・ジェネレータ・デバイス；以下SHGと略記する)52が配置され、レーザダイオード21'のレーザ光の2次高調波、つまり

[0029]

Diagram 2 shows the fluorescent observing apparatus 51 of the second Example of this invention.

In this second Example, secondary higher-harmonics generation element (it is almost described as below second * harmonic * generator * device;SHG) 52 is arranged in front of laser-diode 21' in light-source-device for excitation 5'.

It is made to output the laser radiation of the

その波長の1/2の波長のレーザ光を出力するよう正在する。このレーザダイオード21'は赤外域等の長波長のレーザ光を発光するレーザダイオードであり、その波長を1/2にしたレーザ光が励起用光の波長になる。

wavelength of secondary higher harmonicss of the laser radiation of laser-diode 21', i.e., 1/2 of the wavelength.

This laser-diode 21' is a laser diode which emits light in the laser radiation of long wavelengths, such as an infrared region.

The laser radiation which made the wavelength 1/2 becomes the wavelength of the light for excitation.

【0030】

上記レーザダイオード21'はタイミングコントローラ53からの制御パルスによって、パルス的な駆動電流を出力するレーザダイオード駆動回路54によってパルス的（例えばパルス周期Pは1/数100S）に明滅発光するよう正在している。

[0030]

It is made to carry out the blinking light emission of above laser-diode 21' by the laser-diode driving circuit 54 which outputs a pulse driving current according to the control pulse from the timing controller 53 at a pulse target (for example, pulse cycle P 1/number 100 S).

【0031】

また、第1実施例におけるTVカメラ3内のイメージ・インテンシファイア39を介することなく、蛍光像がCCD41に結像される。このTVカメラ3内のCCD36、41はそれぞれドライバ55、56により駆動される。この場合、CCD36は例えば1フレームの読み出し周期が1/30Sで駆動され、一方CCD41はパルス周期Pの2倍で駆動され、励起光パルスが出力された時と、されない時のCCD41の撮像信号が出力されることになる。さらにこ

[0031]

Moreover, a fluorescent image is image-formed by CCD41, without via the image * intensifier 39 in the TV camera 3 in the 1st Example.

The CCD 36 and 41 in this TV camera 3 is respectively driven by drivers 55 and 56. In this case, as for CCD36, the reading cycle of 1 frame is driven, for example, by 1/30S.

On the one hand, the driving of CCD41 is carried out by the double of pulse cycle P. The photographing signal of CCD41 when an excitation-light pulse is output and when it not be output.

Furthermore the fluorescent-diagnosis apparatus 57 in this Example consists of a two-dimensional lock-in amp 58, CCU59, and a

の実施例における蛍光診断装置 monitor 60.

57は、2次元ロックインアンプ58と、CCU59と、モニタ60とから構成される。

[0032]

2次元ロックインアンプ57は前記CCD41の出力信号をデジタルデータに変換するA/D変換器61と、前記タイミングコントローラ53と同期し、レーザダイオード52の明と滅（点滅）に合わせ、それぞれの画像データをフレームごとに第1フレームメモリ62aと第2フレームメモリ62bに分けるマルチプレクサ63と、第1フレームメモリ62aと第2フレームメモリ62bの画像データの差分を求め、ノイズ分をキャンセルする差分回路64と、ノイズ分がキャンセルされた画像データを累算的に積分（対応する同じ画素部分を繰り返し加算する）することにより増幅する積分回路65とから成る。

[0032]

The two-dimensional lock-in amp 57 consists of A/D converter 61 which carries out conversion of the above-mentioned output signal of CCD41 to digital data, the multiplexer 63 which synchronizes with the above-mentioned timing controller 53 and divides each image data into 1st frame-memory 62a and second frame-memory 62b for every frame according to blink and non-blink of a laser diode 52, the differential circuit 64 which asks for the difference of the image data of 1st frame-memory 62a and second frame-memory 62b, and cancels a part for a noise, and the integration circuit 65 which amplifies in terms of an accumulation by integrating the image data with which the noise was cancelled, (corresponding pixel part repeated and added).

[0033]

この2次元ロックインアンプ57において、レーザダイオード52の明と滅でそれぞれ撮像された画像データを差分回路64で差分処理することにより、この明と滅に無関係なノイズ成分を大幅に低減でき、また低い周波数で顕著になる1/fノイズ

[0033]

In this two-dimensional lock-in amp 57, the noise component irrelevant to this blink and non-blink can be sharply reduced, by differential-processing of the image data respectively photographed by blink and non-blink of a laser diode 52 in the differential circuit 64.

Moreover influence of 1/f noise which

の影響を低減でき、さらに積分回路 65 で積分処理することに

より、非常に S/N の高い蛍光画像データを生成できる。

becomes remarkable on a low frequency can be reduced.

Furthermore by integral processing by the integration circuit 65, the fluorescent image data with very high S/N are generable.

【0034】

なお、この積分回路 65 による積分処理により、1/30S の画像データにされ、図示しない

D/A 変換器でアナログ画像信号に変換された後、CCU59 に入力され、この CCU59 で

標準的な映像信号に変換され、モニタ 60 で蛍光画像が表示さ

れる。

[0034]

In addition, it makes the image data of 1/30S by the integral process by this integration circuit 65.

After carrying out conversion to an analog image signal with D / A converter not illustrated, it is input into CCU59.

It is converted to a standard video signal by his CCU59.

A fluorescent image is displayed with a monitor 60.

【0035】

その他、レーザダイオード 21' の温度を実際に望む励起光の 2 倍の波長になるように制御したり、撮像系のフィルタを観察する蛍光の波長に応じて選択設定する構成等は第 1 実施例と同様である。

[0035]

In addition, it controls to become the wavelength of the double of the excitation light which actually desire the temperature of laser-diode 21'.

Moreover, the constitution which carries out a choice setup depending on the fluorescent wavelength which observes the filter of photographing system is the same as that of the 1st Example.

【0036】

この第 2 実施例によれば、直接励起光の波長で発光するレーザダイオード 21 の代わりに、2 倍の波長となる長い波長のレーザ光を発生する低価格のレーザダイオード 21' を用いること

[0036]

According to this second Example, instead of the laser diode 21 which emits light on the wavelength of direct excitation light, a reasonable laser-diode 21' which produces the laser radiation of a long wavelength which becomes the wavelength of a double can be

ができるので、さらに低コストで実現できる。また、2次元ロックインアンプ57を用いることにより、非常にS/Nの良い蛍光画像が得られる。図3は本発明の第3実施例の内視鏡装置71を示す。第2実施例では内視鏡2の外部の励起用光源装置5内にレーザダイオード21'等を設けたが、この実施例では内視鏡72内部にレーザダイオード21'等を設け、外部のレーザダイオード電源回路73から必要な電源を供給するようにしている。

【0037】

図4にも示すようにこの内視鏡72の挿入部74内には第1実施例と同様にライトガイド15とイメージガイド32とが挿通され、先端部には照明レンズ75と対物レンズ31とがそれぞれ配置されている。この内視鏡72ではさらに、挿入部74の先端部に、電子冷却・加温手段24に取り付けられたレーザダイオード21' と、SHG52と照明レンズ76とが配置されている。

【0038】

レーザダイオード21' と電子冷却・加温手段24は信号線77と接続され、この信号線77はライトガイドケーブル14か

used. Therefore, it is furthermore realizable by being inexpensive.

Moreover, the fluorescent image with very sufficient S/N is obtained by using the two-dimensional lock-in amp 57.

Diagram 3 shows the endoscope apparatus 71 of the 3rd Example of this invention.

In the second Example, laser-diode 21' etc. was provided in the light source device for excitation 5 of the outside of an endoscope 2.

However, in this Example, laser-diode 21' etc. is provided to endoscope 72 inside.

It is made to supply a required power supply from the external laser-diode power supply circuit 73.

[0037]

As shown also in Diagram 4, in the insertion part 74 of this endoscope 72, a light guide 15 and the image guide 32 are passed through like the 1st Example. The illumination lens 75 and the objective lens 31 are respectively arranged by the point.

In this endoscope 72, laser-diode 21' attached in the electronic cooling and heating means 24, and SHG52 and the illumination lens 76 are further arranged at the point of an insertion part 74.

[0038]

Laser-diode 21' and the electronic cooling and heating means 24 are connected with a signal line 77.

This signal line 77 is passed through in the

ら分岐された信号ケーブル 78 内を挿通され、レーザダオード電源回路 73 のレーザダオード駆動回路 54 と電子冷却・加温手段用電源回路 25 にそれぞれ接続される。その他は第 2 実施例と同様の構成であり、その作用効果も第 2 実施例とほぼ同様である。

inside of the signal cable 78 branched from the light-guide cable 14.

It respectively connects with the laser-diode driving circuit 54 of the laser-diode power supply circuit 73 and the power supply circuit for the electronic cooling and heating means 25.

The others are the similar constitution as the second Example.

The effect is the same as that of the second Example almost.

【0039】

なお、内視鏡 72 内にレーザダイオード 21' 及び SHG 52 を収納し、信号線を介してレーザダイオード 21' に対し、外部のレーザダイオード 21' から駆動信号を供給するようにして、単にレーザダイオード 21' の $1/2$ の波長の励起光を出射できるようにしても良い。この場合にも以下の利点がある。

[0039]

In addition, laser-diode 21' and SHG52 are accommodated in an endoscope 72. It is made to supply a driving signal from external laser-diode 21' to laser-diode 21' through a signal line.

It is only made to carry out the radiation of the excitation light of the wavelength of $1/2$ of laser-diode 21'.

Also in this case there are the following advantages.

【0040】

例えば、442 nm の励起光が必要になる場合、通常は He-Cd レーザを用いる場合が多いが、大型であるし、高価である。この励起光が必要な場合、882 nm の波長のレーザ光を出すレーザダイオードは低価格で求めることができるので、He-Cd レーザの代わりに用いると低コストで同じ機能を実現できる。また、レーザダイオード

[0040]

For example, although when 442 nm excitation light are needed, a He-Cd laser is usually used in many cases, it is large-sized and also expensive.

When these excitation light are required, since it can obtain the laser diode which emits the laser radiation whose wavelength is 882 nm at a low cost, if it uses instead of a He-Cd laser, it can materialize the same function by being inexpensive.

Moreover, since a laser diode is made very

は非常に小型にできるので、内視鏡の先端部内に収納することもできる。

small, it can also be accommodated in the end of an endoscope.

【0041】

図5は本発明の第4実施例の内視鏡装置81を示す。この実施例は硬性内視鏡82と、この硬性内視鏡82のライトガイドに通常観察のための照明光を供給する内視鏡用光源装置4と、励起用レーザ光を供給する励起用光源装置5' と、硬性内視鏡82の接眼部83に接続されるスコープホルダ84と、このスコープホルダ84の基端に設けられたTVカメラ85と、このTVカメラ85に対する信号処理を行うと共に、内視鏡像と蛍光像とを表示する内視鏡像&蛍光像表示装置86とから構成される。

[0041]

Diagram 5 shows the endoscope apparatus 81 of the 4th Example of this invention.

This Example is constituted of the hard endoscope 82, the light source device for endoscopes 4 which supplies the illumination light for a usual observation to the light guide of this hard endoscope 82, the light-source-device 5' for excitation which supplies the laser radiation for excitation, the scope holder 84 connected to the eye-piece part 83 of the hard endoscope 82, the TV camera 85 provided to the base end of this scope holder 84, and the endoscope image & fluorescence image display device 86 which displays an endoscope image and a fluorescent image while performing the signal processing opposing to this TV camera 85.

【0042】

硬性内視鏡82の挿入部89の後端に形成された把持部90のライトガイド口金にはライトガイドケーブル14が接続され、途中で分岐された一方のライトガイドケーブル14aは内視鏡用光源装置4に接続され、この光源装置4から白色照明光が供給される。

[0042]

The light-guide cable 14 is connected to the light-guide mouthpiece of the holding part 90 formed on the rear end of the insertion part 89 of the hard endoscope 82. One light-guide cable 14a branched on the way is connected to the light source device for endoscopes 4.

A white illumination light is supplied from this light source device 4.

【0043】

このライトガイドケーブル14

[0043]

Branched laser guide cable 14b in this light-

における分岐されたレーザガイドケーブル 14 b は励起用光源装置 5' に接続され、この光源装置 5' は励起用レーザ光を供給する。白色照明光又は励起用レーザ光は硬性内視鏡 82 内のライトガイドにより伝送され、先端部側の端面から出射される。

guide cable 14 is connected to light-source-device 5' for excitation.

This light-source-device 5' supplies the laser radiation for excitation.

A white illumination light or the laser radiation for excitation is transmitted by the light guide in the hard endoscope 82.

A radiation is carried out from the end face of the end side.

【0044】

照明された診断部位で反射された光或は励起光により発光する蛍光は先端部の対物レンズを介して結像され、リレー光学系等のイメージガイドで後方に伝送され、伝送された像は可視像の場合には接眼部 83 から観察することができる。

[0044]

The fluorescence which emits light by the light or the excitation light reflected by the illuminated diagnostic site is image-formed through the objective lens of a point.

It transmits back by image guides, such as a relay optical system. In the case of a visual image, the transmitted image can be observed from the eye-piece part 83.

【0045】

この接眼部 83 に接続されるスコープホルダ 84 は例えばロッドレンズが内蔵されたアーム部 84 a と、回動自在の関節部 84 b とを有し、接眼部 83 に伝送された像をその基端に接続した T V カメラ 85 に伝送する。

[0045]

The scope holder 84 connected to this eye-piece part 83 has for example, the arm part and 84as by which the rod lens was incorporated, and rotatable joint part 84b.

It transmits the image transmitted to the eye-piece part 83 to the TV camera 85 which connected to the base end.

【0046】

この T V カメラ 85 の入射光路上にはプランジャ 37 により退避可能なミラー 35 が配置され、このミラー 35 で反射された光は第 2 のミラー 92、第 3

[0046]

The mirror 35 which can be evacuated by a plunger 37 is arranged on the incident-light path of this TV camera 85.

The light reflected by this mirror 35 is reflected by the 2nd mirror 92 and the third mirror 93.

のミラー93で反射され、プラ
ンジャー94により光路上から退
避可能な第4ミラー95を経て
CCD96に結像される。

It image-forms on CCD96 through the 4th
mirror 95 which can be evacuated from on an
optical path with a plunger 94.

【0047】

また、上記ミラー35及び95
が退避された場合にはモータ97
で回転されるフィルタターレ
ット98のフィルタ、イメージ
・インテンシファイヤ39を
介してCCD96に結像され
る。

[0047]

Moreover, when the above mirrors 35 and 95
are evacuated, it image-forms on CCD96
through the filter of the filter turret 98 rotated by
the motor 97, and the image * intensifier 39.

【0048】

なお、フィルタターレット98
のフィルタをスイッチ操作等
で、モータ97を介して蛍光撮
像系の光路上に配置できるよう
にしても良い。この実施例は共
通のCCD96を用いて通常の
内視鏡像と蛍光像とを得られ
る。その他は第1実施例とほぼ
同様の効果を有する。

[0048]

In addition, it may arrange the filter of the filter
turret 98 on the optical path of a fluorescent
photographing system through a motor 97 by
switch operation etc.

This Example is obtained in a usual
endoscope image and a usual fluorescent
image using common CCD96.

The others have the almost similar effect as
the 1st Example.

【0049】

なお、励起光の波長領域を広げ
るために、発光波長が異なる複
数のレーザダイオードを用いる
ようにして、実際に必要となる
励起光の波長に応じて使用する
レーザダイオードを選択するよ
うにしても良い。

[0049]

In addition, in order to extend the wavelength
area of excitation light, some laser diodes
whose light-emission wavelength differs is
used.

It may be made to choose the laser diode
used depending on the wavelength of excitation
light which is actually needed.

【0050】

この場合、SHGも必要に応じ

[0050]

In this case, it may be made to use SHG

て使用するようにしても良い。また、発光出力を上げるために、同一の波長で発光するレーザダイオードを複数用いるようにしても良い。なお、上述した実施例等を部分的等で組み合わせても良い。

【0051】

depending on the need.

Moreover, it may be made to use the laser diode which emits light on an identical wavelength, in order to raise a light-emission output multiply.

In addition, it may combine the above-mentioned Example in partial etc.

[0051]

【発明の効果】

以上説明したように本発明によれば、励起光に使用される半導体レーザの温度を制御して発光する波長を可変できるようにすると共に、対象組織側からの蛍光を蛍光撮像系に選択的に導くフィルタ手段とを設けているので、小型で低価格の蛍光観察装置を実現できる。

[EFFECT OF THE INVENTION]

As explained above, according to this invention, While enabling it to control temperature of the semiconductor laser used for excitation light, and to vary the wavelength which emits light, filter means to guide the fluorescence from an objective structure side to a fluorescent photographing system selectively is provided. Therefore, a small and reasonable fluorescent observing apparatus is realizable.

【図面の簡単な説明】

[BRIEF EXPLANATION OF DRAWINGS]

【図 1】

本発明の第 1 実施例の蛍光観察装置の構成を示す構成図。

[FIGURE 1]

The block diagram showing the constitution of the fluorescent observing apparatus of the 1st Example of this invention.

【図 2】

本発明の第 2 実施例の蛍光観察装置の構成を示す構成図。

[FIGURE 2]

The block diagram showing the constitution of the fluorescent observing apparatus of the second Example of this invention.

【図 3】

[FIGURE 3]

本発明の第3実施例の蛍光観察装置の構成を示す構成図。

The block diagram showing the constitution of the fluorescent observing apparatus of the 3rd Example of this invention.

【図4】

第3実施例に用いられる内視鏡の光学系の構造を示す説明図。

[FIGURE 4]

Explanatory drawing showing the structure of the optical system of an endoscope used for a 3rd Example.

【図5】

本発明の第4実施例の蛍光観察装置の構成を示す構成図。

[FIGURE 5]

The block diagram showing the constitution of the fluorescent observing apparatus of the 4th Example of this invention.

【符号の説明】

- 1 … 蛍光観察装置
- 2 … 内視鏡
- 3 … TV カメラ
- 4 … 内視鏡用光源装置
- 5 … 励起用光源装置
- 6 … CCU
- 7 … 内視鏡像モニタ
- 8 … 蛍光診断装置
- 9 … フィルタ切換え制御手段
- 10 … 観察切換手段
- 11 … 挿入部
- 13 … 接眼部
- 14 … ライトガイドケーブル
- 14 b … レーザガイドケーブル
- 15 … ライトガイド
- 17 … ランプ
- 19 … 遮光板
- 21 … レーザダイオード
- 23 … レーザダイオード電源回路
- 24 … 電子冷却・加温手段

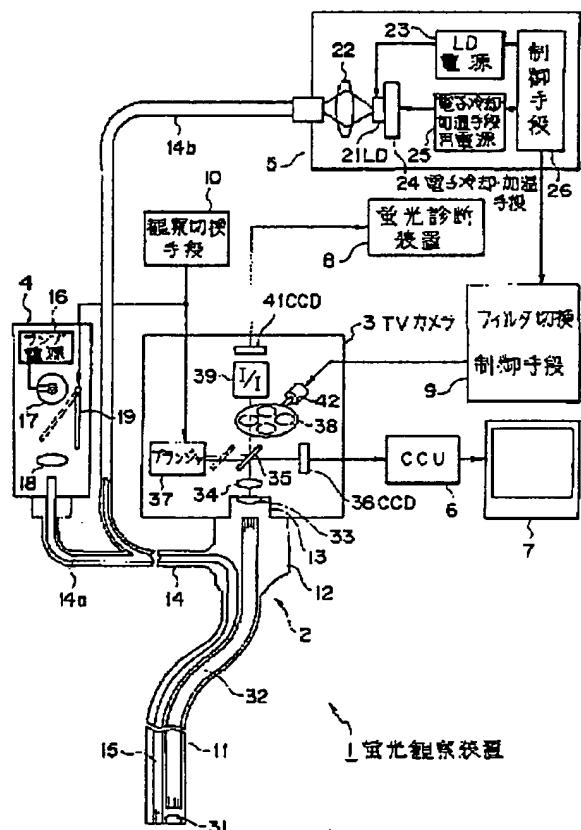
[EXPLANATION OF DRAWING]

- 1... fluorescent observing apparatus
- 2... endoscope
- 3... TV camera
- 4... light source device for endoscopes
- 5... Light source device for excitation
- 6...CCU
- 7... endoscope image monitor
- 8... fluorescent-diagnosis apparatus
- 9... filter switching control means
- 10... observation switching means
- 11... insertion part
- 13... eye-piece part
- 14... light-guide cable
- 14b... laser guide cable
- 15... light guide
- 17... lamp
- 19... shading board
- 21... laser diode
- 23... laser-diode power supply circuit
- 24... electronic cooling and heating means
- 25... Power supply circuit for electronic cooling

25…電子冷却・加温手段用電源回路	and heating means
26…制御手段	26... control means
35…ミラー	35... mirror
36、41…CCD	36, 41...CCD
38…フィルタターレット	38... filter turret
39…イメージ・インテンシファ	39... image * intensifier
アイア	

【図1】

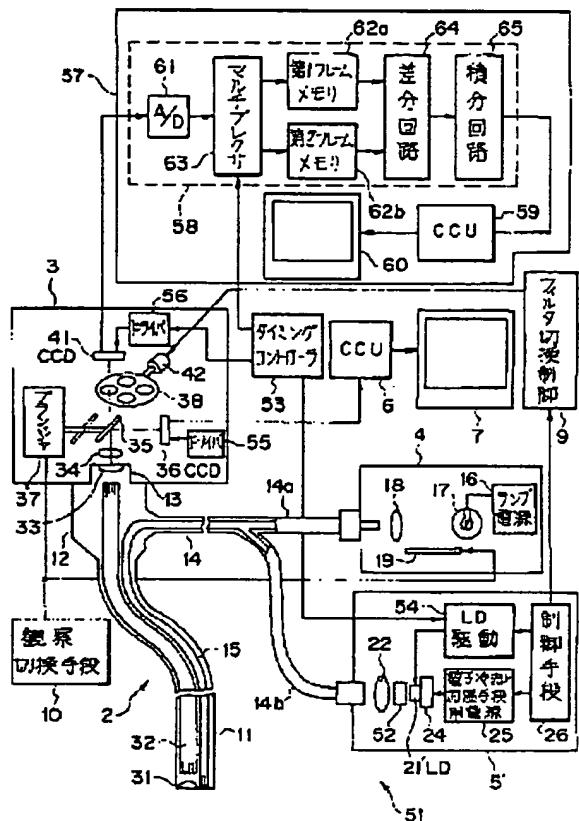
[FIGURE 1]



1 : Fluorescent observing apparatus, 3 : TV camera, 8 : Fluorescent-diagnosis apparatus, 9 : Filter switching control means, 10 : Observation switching means, 16 : Lamp Power supply, 23 : Laser-diode power supply circuit, 24 : Electronic cooling and heating means, 25 : Power supply circuit for Electronic cooling and heating means, 26 : Control means, 37 : Plunger

【図2】

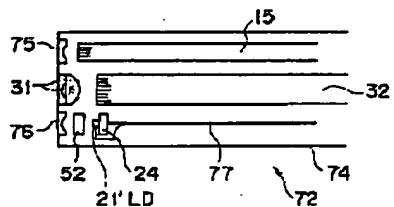
[FIGURE 2]



9 : Filter switching control means, 10 : Observation switching means, 25 : Power supply circuit for Electronic cooling and heating means, 26 : Control means, 37 : Plunger, 53 : Timing controller, 54 : LD driving, 55 : Driver, 56 : Driver, 62a : The first frame memory, 62b : The second frame memory, 63 : Multiplexer, 64 : Differential circuit, 65 : Integral circuit

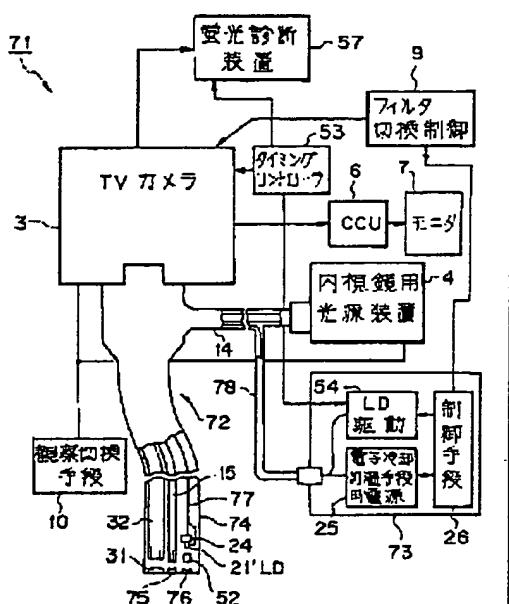
【図 4】

[FIGURE 4]



【図 3】

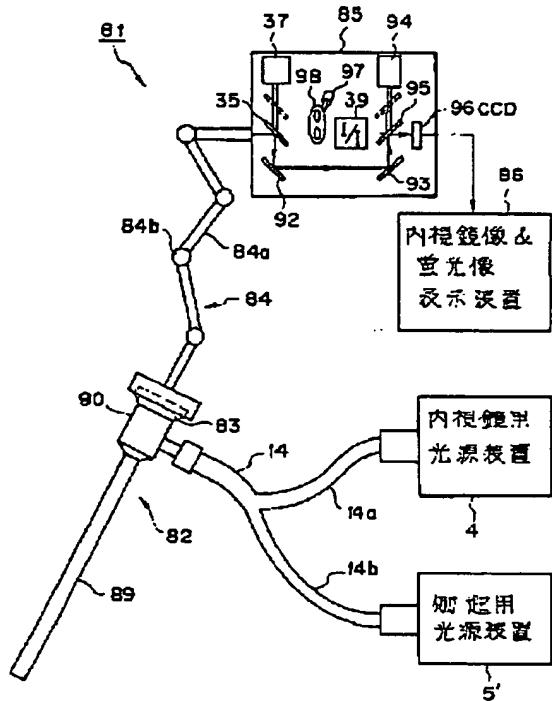
[FIGURE 3]



3 : TV camera, 4 : Light source device for endoscopes, 7 : monitor 9 : Filter switching control means, 10 : Observation switching means, 25 : Power supply circuit for Electronic cooling and heating means, 26 : Control means, 53 : Timing controller, 54 : LD driving, 55 : Driver, 56 : Driver, 57 : Fluorescence observing endoscope apparatus,

【図5】

[FIGURE 5]



4 : Light source device for endoscopes, 5' : Light source device for excitation,
86 : endoscope image & fluorescence image display device

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